Description

Illumination arrangement

The invention relates to an illumination arrangement having an optical waveguide, a light source, which couples emitted light into the optical waveguide, and having a mount for the optical waveguide.

Arrangements of this type, in which a light-emitting diode or a laser diode is often used as light source, have applications in general illumination or as background illumination for liquid-crystal displays (LCD). In this case, the optical waveguide performs the function of guiding the light which is emitted by the light source and is coupled out from the optical waveguide at the end of the optical waveguide or at a window provided for this. The surface of the optical waveguide is structured for this purpose in the window region, e.g. by knobs, grooves, or by some other roughening in order to homogenize the light exit. The optical waveguides are composed of transparent material, for example epoxy resin or polymethyl methacrylate (PMMA). In the course of guiding the light and its necessary deflection in the optical waveguide, on the one hand the light lost must be as little as possible, and on the other hand cost-effective production and also practical and simple assembly must be possible.

In the exemplary embodiment shown in Figure 5, a light-emitting diode 50 couples its light into an optical waveguide 51 plugged into a mount 52a, 52b. The mount 52 and the light-emitting diode 50 are mounted on a printed circuit board (PCB) 53. The light emitted by the light-emitting diode 50 is deflected at a bevel 54 of the optical waveguide by total reflection. For production engineering reasons, in particular in favor of ease of assembly, the bevel 54 is not covered with a

reflective material. During the deflection of the light at the bevel 54, which is angled by preferably 45°, light necessarily emerges from the optical waveguide, which light is lost for the envisaged application purpose since it is not guided any further in the optical waveguide. On the other side, the mounts 52a, 52b simultaneously serve as reflectors which prevent light from emerging from the optical waveguide 51 on these sides. When observing the surface of the optical waveguide from the direction B, for example when the optical waveguide is embodied as LCD background illumination, some regions on the optical waveguide surface appear brighter than others (hot spots) as a result of the light deflection at the boundary surface 54 and the direct radiation of the light source. Hot spots are bright surface regions which appear in light exit window and cannot be corrected by the surface configuration of the optical waveguide in the light exit window. Producing a special reflector for the inclined surface 54 in the form of an injection-molded part seems to be too costly, on the other hand, on an industrial scale since it is too expensive overall.

The invention is based on the object of specifying an illumination arrangement of the type mentioned in the introduction and a method for producing it by means of which an improvement is made possible in a cost-effective manner.

The invention achieves this object by means of the features of patent claims 1 and 14. Refinements of the invention are characterized in subclaims.

The invention is described below using exemplary embodiments which are illustrated in the figures of the drawing, in which:

Figure 1 shows a diagrammatic cross section through an illumination arrangement according to the invention,

Figure 2	shows side views of a mount for the optical waveguide
Figure 3	shows a diagrammatic cross section of a special embodiment of the invention,
Figure 4	shows a further, partially perspectively illustrated embodiment of the invention, and
Figure 5	shows a diagrammatic cross-sectional illustration of previously used illumination arrangements.

Figure 1 shows an illumination arrangement 1 in a cross-sectional illustration. The arrangement comprises a mount 10 or an optical waveguide 11, into which one or more light sources 12a, 12b feed light. The light sources 12 are preferably light-emitting diodes (LED) or laser diodes, but other light sources such as incandescent lamps are also possible. The light source 12 and the mount 10 are mounted on a printed circuit board 14. The mount 10 surrounds the optical waveguide 11 in shell form in the regions in which the light has to be deflected and guided. In order to introduce the optical waveguide into the shell, and to be able to mount it, the mount 10 is formed from a plurality of shell elements. In the example of Figure 1, the mount 10 contains on its top side a window 13 through which an observer B can observe the optical waveguide or the light can be coupled out. The window 13 in the mount 10 is configured in such a way that the illumination arrangement can serve as an element of background illumination for liquid-crystal displays.

In accordance with Figure 1, the mount 10 for the optical waveguide 11 simultaneously has the main function of a reflector with the reflector surfaces 16a, 16b, with the aid of which the light beams can be deflected without relatively large light losses arising. The deflection angle is inherently arbitrary, but 90° here. Depending on technical requirements and

specifications, the optical waveguide 11 with the mount 10 is constructed in such a way that the optical losses and/or the hot spots are minimized. The mount 10 is shaped in the light deflection region and in the window region 10, such that light can emerge diffusely through the window 13. The upper reflector surface 16a can be multiply angled or rounded. With respect to the optical waveguide, the lower reflector surface 16b is convexly formed or expanded in order that light cannot emerge in a concentrated manner at one location. Both the optical waveguide 11 and the mount 10 can be produced as injection-molded parts. Transparent material, e.g. PMMA, is used as the optical waveguide. The mount 10 is typically opaque to light and reflective at its inner surfaces in order to reflect back into the optical waveguide the light which emerges at the deflection points of the optical waveguide.

According to the invention, the mount 10 is designed in shell form and contains at least two shell elements. Figure 2 shows a side view of the arrangement in accordance with Figure 1 from viewing direction A. In accordance with Figure 2a), the mount contains for the optical waveguide two shell elements 20 and 21, which are designed largely symmetrically with respect to the central line. In the light propagation direction, the optical waveguide has a largely rectangular cross section. During assembly, the optical waveguide is firstly introduced laterally into one of the two shell elements 20 or 21 and then enclosed by the other half-shell 21 or 20, respectively, at the regions not yet protected.

The two half-shells 20 and 21 are connected by a snap-action device 25, 26. In this case, a lug 25 fixed to the half-shell 21 and having an opening is pushed over a knob 26 fixed to the other half-shell 20. However, the two half-shells can also be connected in any other form which ensures that the two half-shells enclose the

optical waveguide. In addition to a releasable connection such as that using the snap-action devices 25, 26, fixed connections, for example by bonding, are also appropriate. In order to prevent the situation where gaps arising at the abutting edge of the two half-shells 20 and 21, possibly due to material tolerances or due to an aging behavior, lead to the coupling-out of light, it is possible to fold the two shell elements 20 and 21 at their abutting edge, so that the shell elements overlap at the fold and become optically opaque.

Figure 2b shows another arrangement for the two shell elements. In this case, the optical waveguide is firstly introduced from the side into a shell element 22, which encloses the optical waveguide to an extent such that only a cover 23 has to be laterally emplaced in order to enclose the optical waveguide in the light-guiding region. In this exemplary embodiment, the connection between the shell elements 22 and 23 is effected by a plurality of snap-action devices 27, 28. Projecting knobs are arranged on the shell element 22 and the openings in the lugs 28 can latch into said knobs. The advantage of this arrangement is the releasibility of the mount arrangement. It goes without saying that, in an embodiment of Figure 2a, too, the shell elements 22 and 23 can be provided with a fold, so that no light can emerge at the abutting surface.

In the arrangement in accordance with Figure 1, it is possible to feed in light from only one light source 12. Preferably, however, a plurality of light sources 12a, 12b are provided, which, as in Figure 1, feed light into the optical waveguide from both sides. What is more, further light sources may be arranged perpendicularly to the plane of the drawing. This makes it possible to observe a high light intensity at the window 13. With the arrangement in accordance with Figure 1, it is possible for the light that is to be

coupled out, or the observation window 13, to be arranged remote from the light source 12. The optical waveguide 11 and the shell mount 10 can be produced extremely favorably by virtue of the production of injection-molded parts, at the same time the light guidance by virtue of the form of the optical waveguide channels and of the shell mount designed as reflectors being effected so optimally that a maximum of light can be utilized for the illumination purposes. The construction in the form a bridge means that it is possible to produce extremely space-saving arrangements because, below the mount 10 in the free space toward the circuit board 14, further components 15 can be arranged on the circuit board.

Figure 3 shows a partial cross section of a further embodiment of the invention. This provides a shell-type mount 30 for the optical waveguide 31, which in this case are mounted by their side 38 in a planar manner on the circuit board 34. In contrast to Figure 1, the arrangement contains not only an upwardly radiating LED 32 but a chamber 36 separated from the latter by a partition 35, arranged in which chamber is an LED or laser diode 33 radiating sideways over the edges. In this construction, a bridge arrangement as illustrated in Figure 1 is not provided. The advantage of the arrangement in accordance with Figure 3 is that the optical power coupled into the optical waveguide can be considerably higher than in the case of the arrangement in Figure 1. Here, too, the inner surfaces 37 of the mount 30 serve as reflectors.

Figure 4 shows a further, partially perspective exemplary embodiment of the invention, in which the shell elements of the mount are not separated vertically, as illustrated in Figure 2, but horizontally. In this embodiment, the optical waveguide 43 is plugged into the lower shell element 40 from above and subsequently covered by the upper shell

element 42. The lower shell element is mounted on the PCB 45. The upper shell element can be connected to the lower shell element in the manner described with reference to Figure 2. In the exemplary embodiment, 3 LEDs 41a to 41c are provided on each circuit-board side of the optical waveguide, but there may also be more or fewer individual light sources.

Furthermore, there are a multiplicity of possibilities for producing optical waveguides and associated shell elements which enable virtually arbitrary variation for the coupling-in and coupling-out of light. This is because the optical waveguides are largely completely covered by the ~~beam~~ shell-type mount, except for the coupling-in and coupling-out regions, the inner surfaces of the mount serving as reflector surfaces.